



INVESTOR IN PEOPLE

The Patent Office  
 Concept House  
 Cardiff Road  
 Newport  
 South Wales  
 NP10 8QQ

**PRIORITY  
 DOCUMENT**  
 SUBMITTED OR TRANSMITTED IN  
 COMPLIANCE WITH RULE 17.1(a) OR (b)

REC'D 04 OCT 2004	
WIPO	PCT

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 20 May 2004

Patents Act.  
(Rule 16)

**Request for grant of a patent**

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Concept House  
Cardiff Road  
Newport  
South Wales NP10 8QQ

1.	Your reference	AWP/PEH/P62008/000		
2.	Patent application number (The Patent Office will fill in this part)	<div style="text-align: right;">25 MAY 03 09:05:34 -17 047507</div> <div style="text-align: right;">PG1/7700 0.00-0311500.3</div> <div style="text-align: center; font-size: 2em; font-weight: bold;">0311500.3</div> <div style="text-align: right; font-weight: bold;">19 MAY 2003</div>		
3.	Full name, address and postcode of the or of each applicant (underline all surnames)	GIBBS TECHNOLOGIES LIMITED AVENUE ROAD NUNEATON WARWICKSHIRE CV11 4LY		
	Patents ADP number (if you know it)			
	If the applicant is a corporate body, give the country/state of its incorporation	ENGLAND AND WALES <div style="text-align: right; font-size: 1.5em; font-weight: bold;">7866668001</div>		
4.	Title of the invention	A HULL FOR AN AMPHIBIOUS VEHICLE		
5.	Name of your agent (if you have one)	BOULT WADE TENNANT		
	"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	VERULAM GARDENS 70 GRAY'S INN ROAD LONDON WC1X 8BT		
	Patents ADP number (if you know it)	42001		
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number	Country	Priority application number (if you know it)	Date of filing (day/month/year)
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application		Date of filing (day / month / year)
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))	YES		


9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description 7

Claim(s) 3


Abstract 


Drawing(s) 6 


10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (*Patents Form 7/77*) 1 

Request for preliminary examination and search (*Patents Form 9/77*) 1 

Request for substantive examination (*Patents Form 10/77*) 1 


Any other documents  
(Please specify)

11

I/We request the grant of a patent on the basis of this application.

Signature

Date



19 MAY 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

PAUL HICKS  
020 7430 7500

**Warning**

*After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.*

**Notes**

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 01645 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

## A HULL FOR AN AMPHIBIOUS VEHICLE

5 The present invention relates to a hull and, in particular, to a hull for an amphibious vehicle.

10 The designers of planing hulls for watercraft usually adopt a deadrise angle of between 14 and 18 degrees amidships. The angle may flatten along the run aft to 2.5 to 4 degrees at the transom. The applicant has determined that for an amphibious vehicle with a planing hull it is desirable to have a maximum deadrise angle of about 6 degrees on the planing surface in order to provide for adequate ground clearance when the vehicle is used on a road. Such a low deadrise angle  
15 detrimentally affects directional stability of a hull when planing on water. In order to address this problem, the applicant provides a pair of strakes running lengthwise along the underside of the hull in order to improve directional stability of the hull when planing on water.

20 Normally it is only slow speed displacement vessels that use a smooth hull without hydrodynamic aids. Traditionally, a keel is a protrusion from the smooth under surface of a hull along its longitudinal centre line. This definition dates back  
25 to the days of wooden ships, when the keel was the first part of the ship to be laid down during its build.

More recently, the term keel has been applied to one, or a pair of, deep fin(s) which extend downwards from a hull on, or on either side of, its longitudinal centre line. Such fins are  
30 also known as skegs, and are particularly popular on sail driven vehicles, from windsurfers to yachts; where their depth can provide great stability against lateral wind forces.

Strakes are relatively shallow structures, of similar depth to a central, full length, keel; but laterally displaced  
35 to either side of a vessel's longitudinal centre line.

Skegs are readily distinguished from strakes, in that:

- a) skegs are only about one quarter the length of the hull, whereas strakes extend along substantially the full hull length;

- b) skegs are themselves of greater depth to the rest of the hull structure - considerably deeper in the case of a windsurfer - whereas a strake would typically be less than 10% as deep as the rest of the hull;
- c) skegs are rarely, if ever, fitted to amphibious vehicles; because they would nullify ground clearance, and because amphibians are not generally wind powered.

Amphibious vehicles operating in displacement mode are limited to a speed of around six knots. At such speeds, which hold little marketing appeal, hydrodynamic aids have little effect; and the vessel remains substantially level when turning. A planing amphibious vehicle, however, may travel on water at 15 knots or more, and will lean into corners; so strakes can be useful hydrodynamic aids.

Keels and strakes are particularly useful for vessels driven by water jets, which have no dependent structures below the general level of the hull. By contrast, the drive pod, propeller, and rudder of an outboard motor can act as lateral stabilizers.

The present invention provides in a first aspect a hull for an amphibious vehicle with an underside submersible in water and at least one strake extending lengthwise along at least part of the underside, wherein the strake at least in part has a pair of surfaces which both extend downwardly from the hull at an angle of 75 degrees to 90 degrees to horizontal when the hull is level, each of the surfaces when immersed in water capable of giving rise to a lateral force on the hull during turning of the hull in water.

The present invention provides in a second aspect a hull for an amphibious vehicle with an underside submersible in water and at least a first pair of strakes extending parallel to each other lengthwise along at least part of the underside, wherein each strake at least in part has a pair of surfaces which both

extend downwardly from the hull at an angle of 75 degrees to 90 degrees to horizontal when the hull is level, each of the surfaces when immersed in water capable of giving rise to a lateral force on the hull during turning of the hull in water.

5 The two strakes of said pair are preferably located one each on either side of a keel provided centrally on the underside of the hull, the strakes being spaced equidistantly from the keel.

10 The strakes of the prior art have been provided in parallel extending pairs on the underside of a hull, but have been triangular in cross-section so that each strake has one side inclined to provide a significant resistive transverse force during turning, but with the other side inclined to provide little resistive transverse force during turning. In  
15 the present invention both sides of each strake are used to provide a significant resistive transverse force.

20 Preferably each strake has a forward part which is substantially triangular in transverse cross-section and a rearward section which is substantially quadrilateral in transverse cross-section. Each section has a pair of surfaces each capable of giving rise to a lateral force, but said forces are greater, and more evenly balanced, at the rearward section.

25 It is preferable to have only at the rear of the hull strakes with a pair of sides capable of giving rise to greater resistive transverse forces, because otherwise the hull will be difficult to turn in water when not planing. It is only the rear of the underside of the hull which remains immersed in  
30 water when the hull is planing.

35 Preferably each strake extends along the majority but not the complete length of the underside of the hull. Preferably each strake does not extend lower than the lowest part of a keel of the hull. Where the hull has removable panels then the strakes can extend over the panels.

Each strake can have a section formed integrally with the hull and a section formed independently of the hull and then

fixed to the hull. The said independently formed sections can be forward or rearward removable sections, so as to ease replacement when damaged. An independently formed section can extend over a removable panel in the underside of the hull and can be removable to allow removal of the removable panel.

A preferred embodiment of hull according to the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a plan view of an underside of a hull according to the present invention;

Figure 2 is a perspective view from below of the hull of Figure 1

Figure 3 is a cross-section through the hull of Figure 1 taken along the line x-x' ;

Figure 4 is a cross-section through the hull of Figure 1 taken along the line y-y' ;

Figure 5 is a detail view of the cross-section of Figure 3; and

Figure 6 is a detail view of the cross-section of Figure 4.

In Figures 1 and 2 there can be seen a hull 11 of an amphibious vehicle 10 having a forward bow end 12 and rear stern end 13. The underside of the hull 11 is shown and provided on the underside are a pair of strakes 14, 15 spaced equidistantly from a keel 16. Each strake 14, 15 runs lengthwise along the underside of the hull 11 for the majority of, but not the whole length of, the hull 11. The underside of the hull 11 is provided with removable panels 7, 8, 17, 18 which are hydrodynamic aids (planing plates) as described in the applicant's co-pending UK patent application entitled 'A Hull For An Amphibious Vehicle', reference AWP/PEH/P62458/000. One section of each strake 14, 15 is formed integrally with the hull 11 and another section formed integrally with, or assembled to, one of the removable panels 17, 18.

The forward sections of the strakes 14, 15 are triangular in cross-section, as can be seen in Figure 3, and in detail for

strake 14 in Figure 5, Figure 5 being an enlarged view of part of the cross-section of Figure 3, showing strake 14 in detail. Looking at Figure 5, it can be seen that the strake 14 has a face 19 which extends at an angle  $\alpha$  of approximately 50 degrees to the horizontal when the hull is level and a face 20 which extends at an angle  $\beta$  of approximately 15 degrees to the horizontal when the hull is level. When the strake 14 moves through the water in the direction of arrow 21 at a first speed then interaction of the face 19 with the water gives rise to a transverse force of a first magnitude on the hull resisting the motion. When the strake 14 moves through the water in the direction of the arrow 22 at the same first speed then interaction of the face 20 with surrounding water gives rise to a transverse force of a second magnitude smaller than the first magnitude, due to the fact that the faces 19 and 20 lie at different angles to the horizontal.

The strake 15 is a mirror image of the strake 14. It too has faces inclined at different angles. Strakes 14 and 15 are shown with rounded corners between faces 19 and 20. This aids demoulding, particularly in series production. If it is desired that any part of strakes 14 and 15 which is not immersed in water should act as a spray rail, it may be moulded with a sharp corner between the inclined faces.

The rearward sections of the strakes 14, 15 are quadrilateral in cross section, as can be seen in Figure 4 and in detail for strake 15 in Figure 6, Figure 6 being an enlarged view of part of the cross-section of Figure 4, showing strake 15 in detail. Looking at Figure 6 it can be seen that the strake has a face 23 which extends at an angle  $\gamma$  of approximately 82 degrees to the horizontal when the hull is level and a face 24 which extends at an angle  $\theta$  of approximately 85 degrees to the horizontal when the hull is level. Alternatively, angles  $\gamma$ ,  $\theta$  may be substantially equal, say 85 degrees. Indeed, angles  $\gamma$ ,  $\theta$  could be any angle from 75 to 90 degrees. The interaction of the face 23 with water gives rise to a significant resistive lateral force when the strake moves in the direction of the arrow 25 and the interaction of the face 24 with water gives rise to a



significant resistive lateral force when the strake moves in the direction of the arrow 26. Strake 14 is of the same cross-section as strake 15, but in mirror image thereto.

5           The quadrilateral shaped sections of the strakes 14, 15 give the hull good turning characteristics since the strakes together present a pair of faces giving rise to lateral forces on the hull for each sense of rotation of the hull, one face being provided by each strake. However, the hull does not  
10 provide excessive resistance to turning when the hull is not planing because of the triangular cross-section shape of the forward sections of the strakes 14, 15.

15           The rearward sections of the strakes 14, 15 can be made independently of the hull 11 and then be fixed to the hull 11. These sections may suffer from wear in use and thus can be made replaceable. They can also be made removable to allow removal of the removable panels 17 and 18.

20           It is preferable that the keel 16 is replaceable and takes the majority of wear during road use of the vehicle, as disclosed in the applicant's co-pending application no. GB0226443.0. The strakes 14 and 15 preferably do not extend  
25 lower than the keel 16 so that the keel preferentially receives ground impacts suffered by the hull in road use rather than the strakes 14, 15.

30           Whilst in the preferred embodiment described above two strakes 14, 15 are provided on the underside of hull 11, it will be appreciated that just one strake or indeed an array of strakes may be beneficially employed. Also, the location of strakes may be varied. Furthermore, whilst the section of the strakes in the preferred embodiment reduces from root to tip (i.e. the faces taper/converge to some degree), it is envisaged  
35 that alternative embodiments of hull according to the present invention could beneficially employ strakes whose section increases from root to tip (i.e. the faces diverge, of so-called 're-entrant' form). This may be achieved with integrally moulded strakes or independent strakes which are assembled or

are retrofit additions.

5       Where the hull is used on an amphibious vehicle, the  
      strakes may be located inboard of wheel arches in the hull. The  
      road wheels may be mounted on retractable suspensions as is  
      known in the amphibious vehicle art, so that the wheels can be  
      retracted on water to reduce hydrodynamic drag.

10

CLAIMS

1. A hull for an amphibious vehicle with an underside submersible in water and at least one strake extending lengthwise along at least part of the underside, wherein the strake at least in part has a pair of surfaces which both extend downwardly from the hull at an angle of 75 degrees to 90 degrees to the horizontal when the hull is level, each of the surfaces when immersed in water capable of giving rise to a lateral force on the hull during turning of the hull in water.
2. A hull for an amphibious vehicle with an underside submersible in water and at least a first pair of strakes extending parallel to each other lengthwise along at least part of the underside, wherein each strake at least in part has a pair of surfaces which both extend downwardly from the hull at an angle of 75 degrees to 90 degrees to horizontal when the hull is level, each of the surfaces when immersed in water capable of giving rise to a lateral force on the hull during turning of the hull on water.
3. A hull as claimed in claim 2 wherein the strakes of the said pair of strakes are located one each on either side of a keel provided centrally on the underside of the hull, the strakes being spaced equidistantly from the keel.
4. A hull as claimed in any one of the preceding claims wherein each strake has a forward part which is substantially triangular in transverse cross-section and a rearward section which is substantially quadrilateral in transverse cross-section.
5. A hull as claimed in any one of the preceding claims wherein each strake extends along the majority of and not the complete length of the underside of the hull.
6. A hull as claimed in any one of the preceding claims wherein the hull has a keel and each strake does not extend lower than the lowest part of the keel.

7. A hull as claimed in any one of the preceding claims wherein the underside of the hull has a plurality of removable panels and at least one strake extends over at least one removable panel.

8. A hull as claimed in any one of the preceding claims wherein at least one section of each strake is formed integrally with the hull.

9. A hull as claimed in any one of the preceding claims wherein at least one section of each strake is formed independently of the hull and then fixed to the hull, the said section of strake being a rearward section of the strake.

10. A hull as claimed in claim 8 wherein at least one section of each strake is formed independently of the hull and then fixed to the hull, the said section of strake being a forward section of the strake.

11. A hull as claimed in claim 9 or claim 10 wherein at least one independently formed section of strake is located extending over a removable panel in the underside of the hull so that the independently formed section of strake can be removed to permit removal of the removable panel.

12. A hull as claimed in any one of the preceding claims having a maximum deadrise angle on the planing surface of 6 degrees.

13. A hull as claimed in any one of the preceding claims wherein the pair of surfaces of at least one section of the at least one strake are convergent such that the section of the strake reduces from root to tip.

14. A hull as claimed in any one of the preceding claims wherein the pair of surfaces of at least one section of the at least one strake are divergent such that the section of the strake increases from root to tip.

15. A hull as claimed in any one of the preceding claims which can be propelled through water to a speed where sufficient hydrodynamic lift is achieved for the hull to plane.

5

16. Use of a hull as claimed in any one of the preceding claims as the hull of an amphibious vehicle.

10 17. An amphibious vehicle incorporating the hull as claimed in any one of claims 1 to 15.

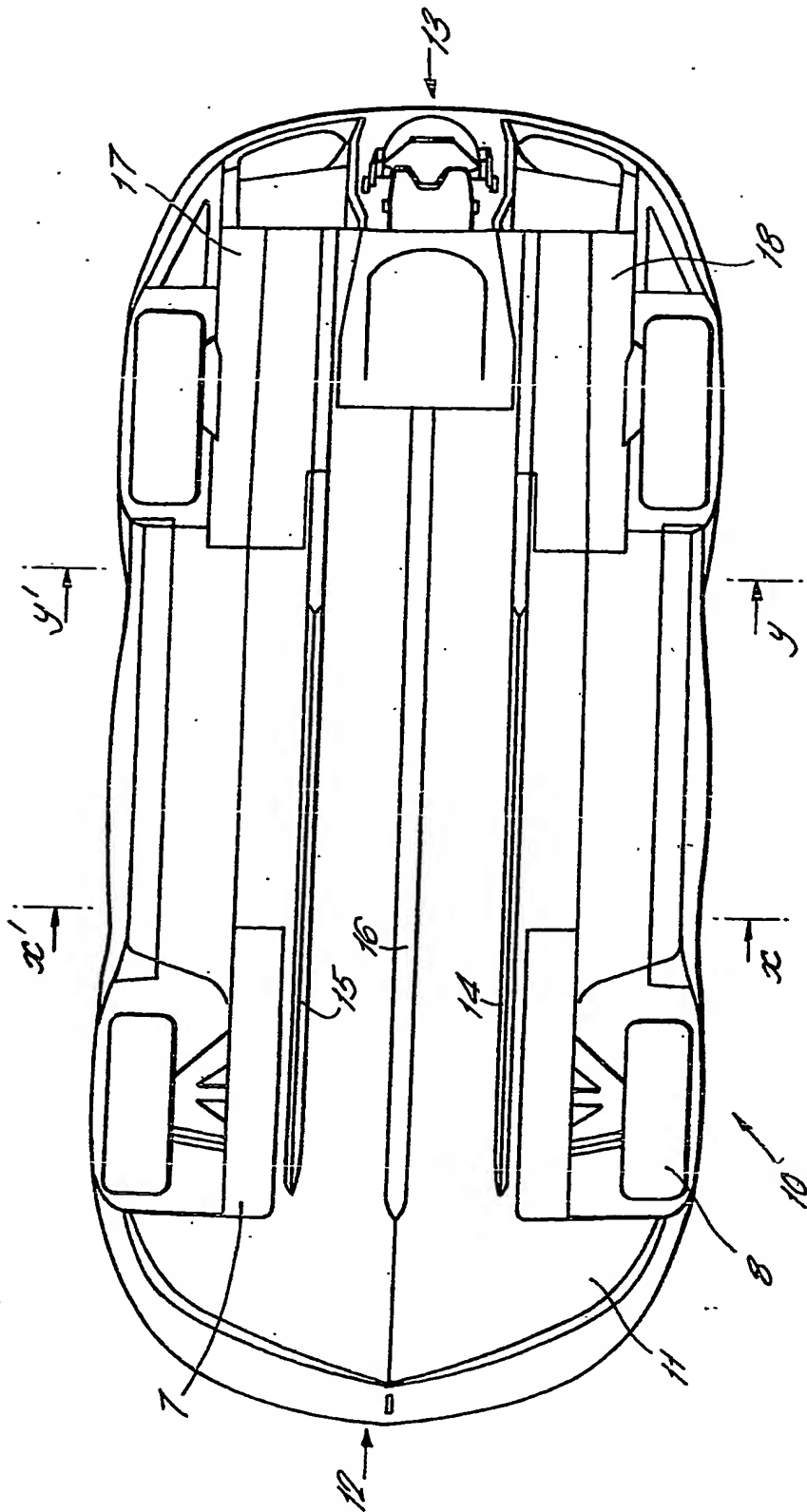
15 18. An amphibious vehicle as claimed in claim 17 further comprising a jet drive used to propel the vehicle through water in a marine mode to a speed where sufficient hydrodynamic lift is achieved for the vehicle to plane.

19. A hull substantially as hereinbefore described with reference to or as shown in the accompanying drawings.

20 20. Use of a hull substantially as hereinbefore described with reference to or as shown in the accompanying drawings.

25 21. An amphibious vehicle substantially as hereinbefore described with reference to or as shown in the accompanying drawings.

FIG. 1.



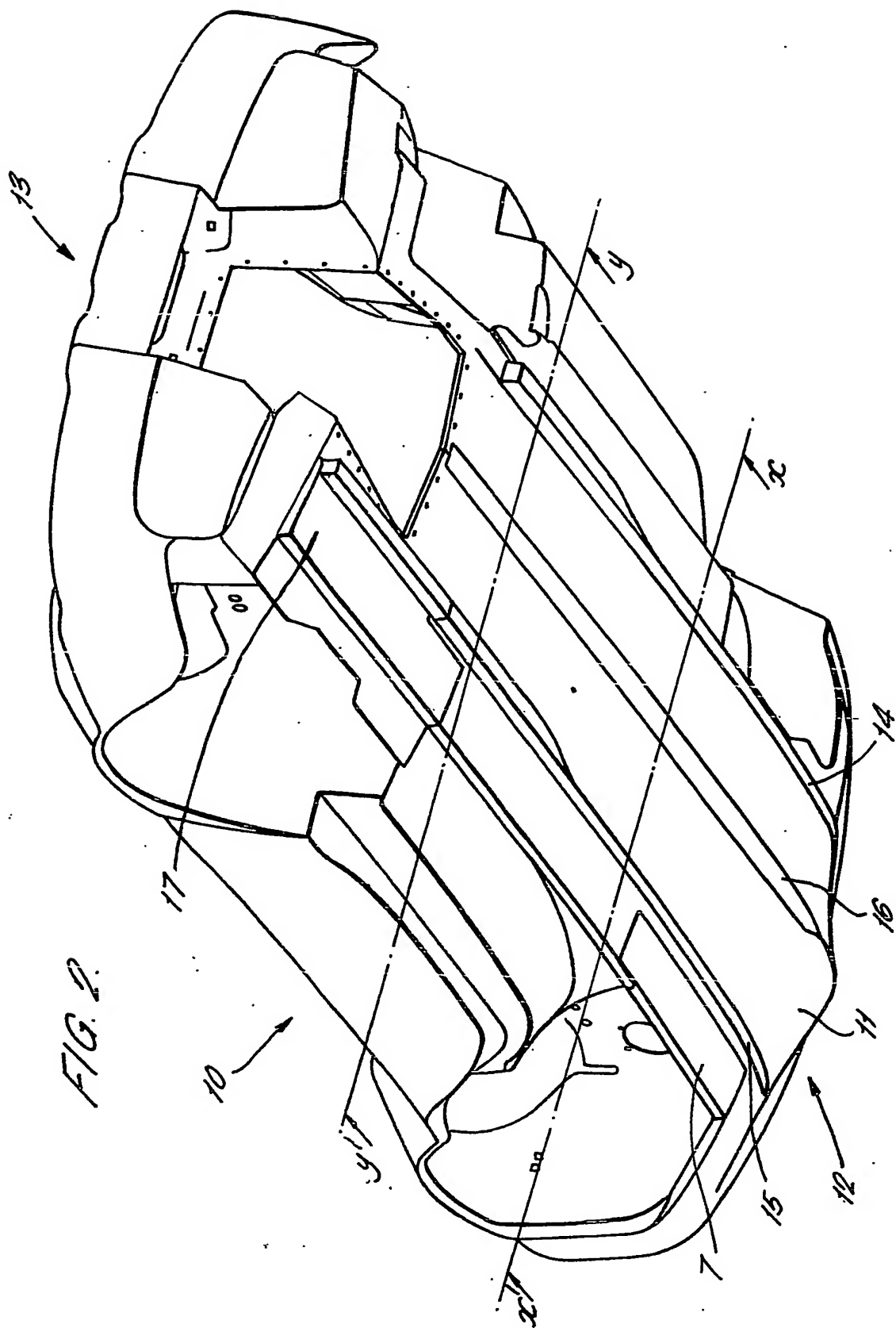
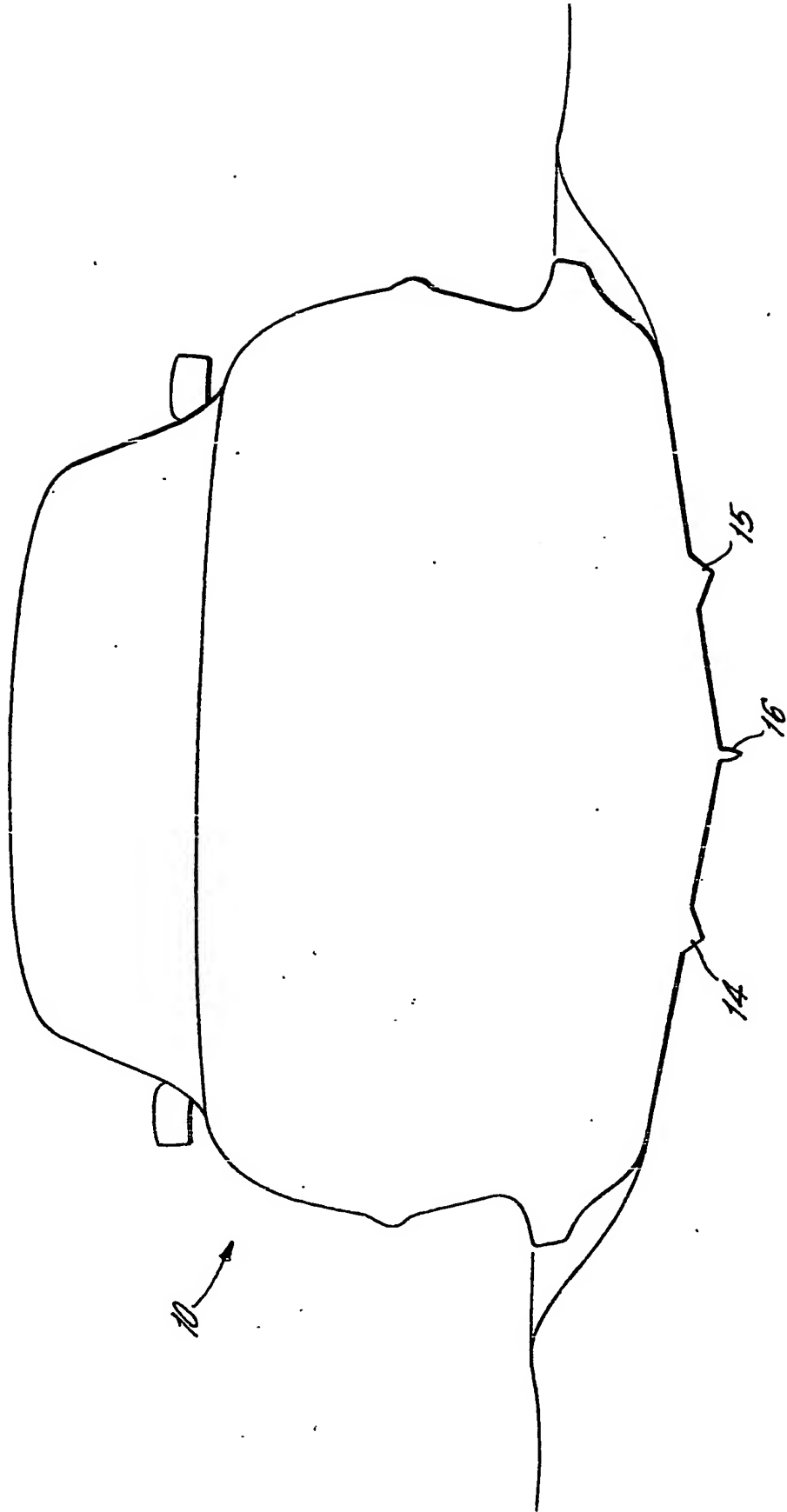


FIG. 2.

FIG. 3.





4/6

FIG. 4.

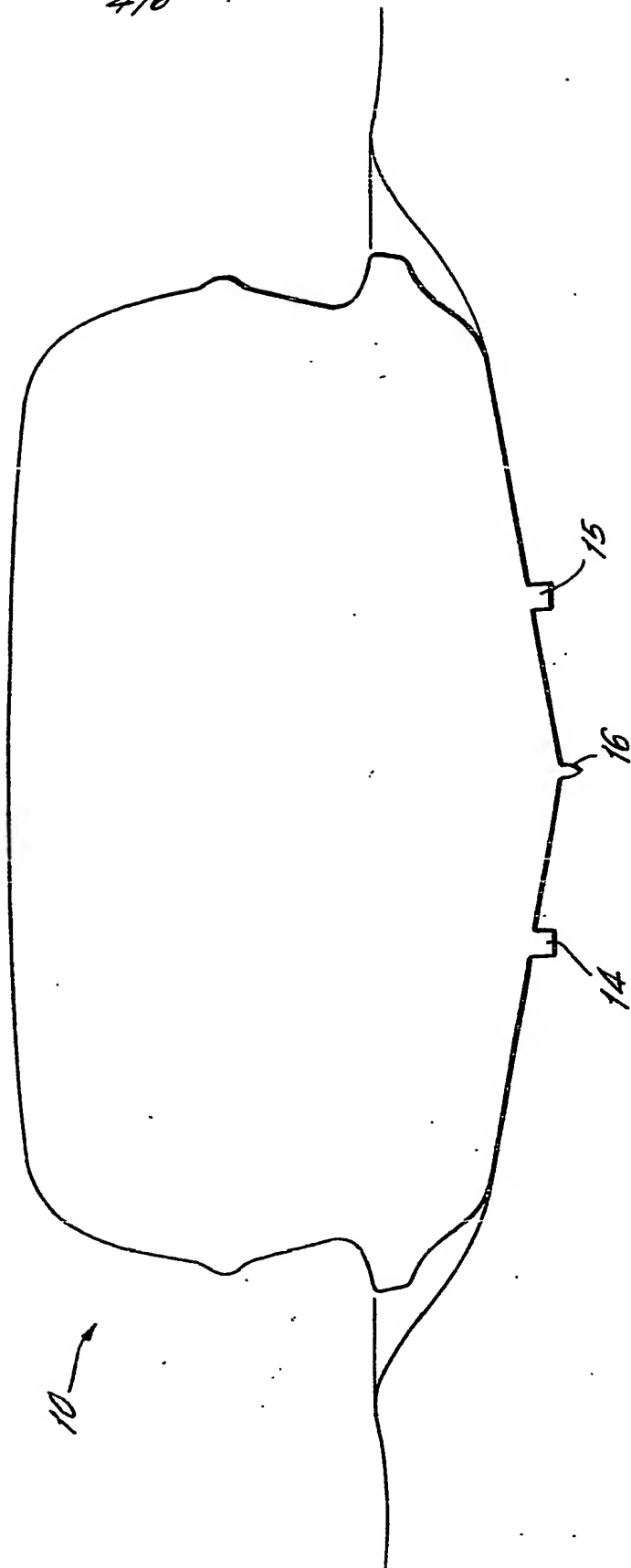


FIG. 5.

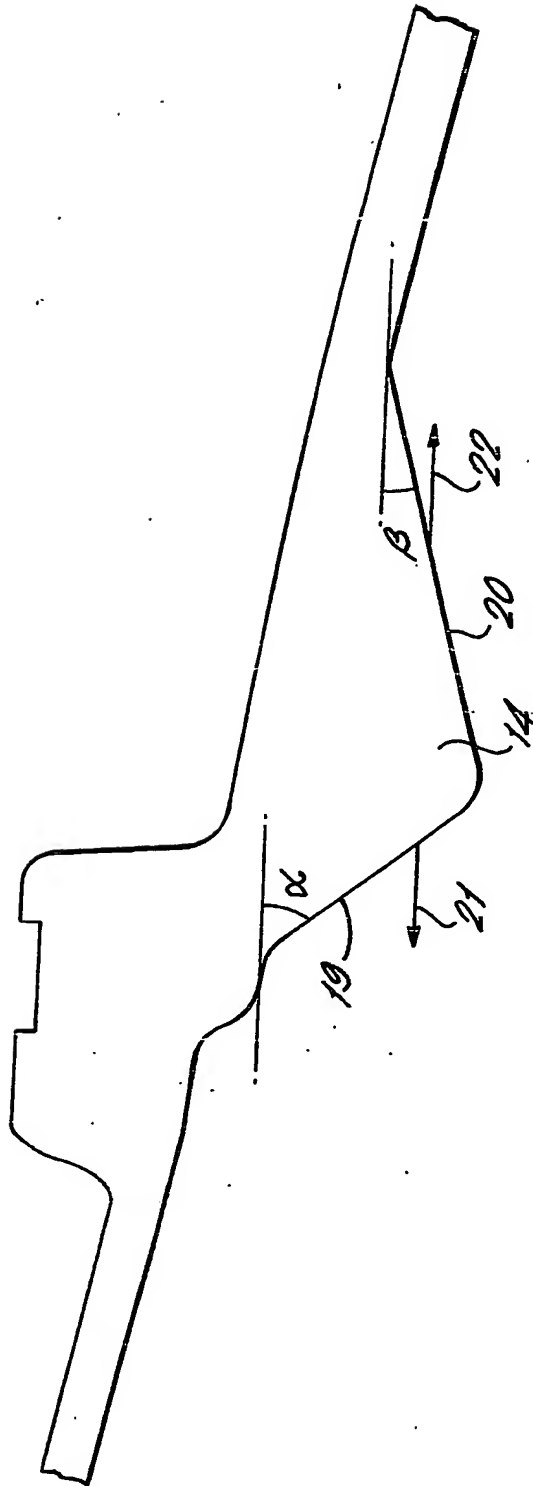
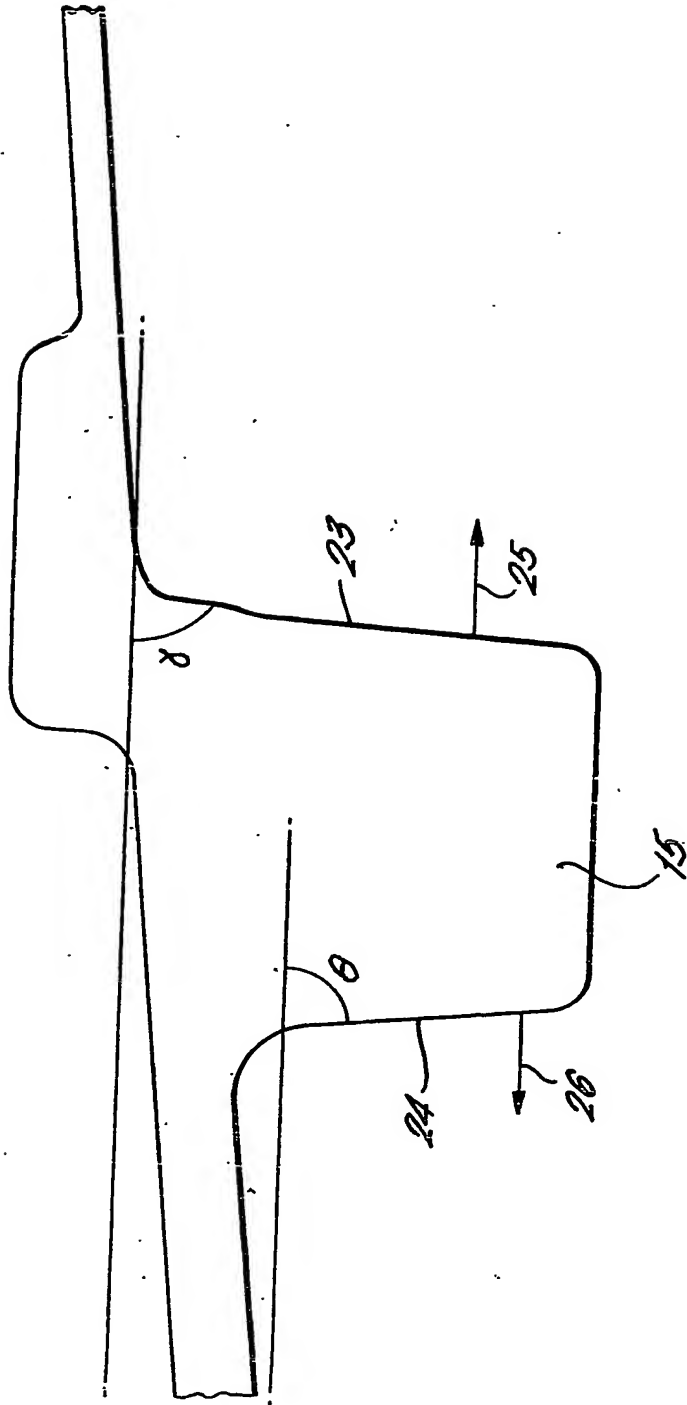


FIG. 6.



**PCT/GB2004/002165**

